well defined as is the thorax by the number of segments which compose it, we may certainly take the three divisions of the body, as they are constituted in insects, as the standard to which the segments of the higher Crustacea are to be referred, if we desire to settle what are their cephalic, thoracic, and abdominal segments. We will not state, then, that the thorax of Arthropoda is normally composed of seven segments. In Isopoda and Amphipoda, where the part usually called the thorax is divided into seven leg-bearing segments, the segment corresponding to the prothorax of insects has completely disappeared, its legs being added to the head in the shape of a lower lip with palpi; the first and second of the seven leg-bearing segments are analogous to the meso- and metathorax, and the five others, as well as the segments of the so-called abdomen, to abdominal segments,—the abdomen being here, as in all higher Crustacea, composed of a greater number of segments than in insects, and divided into an anterior (pectoral) and posterior (caudal) portion*. To the five segments constituting the pectoral part of the abdomen in Isopoda the five leg-bearing segments of Decapoda are analogous, whose thoracic segments are all united to the head (their legs constituting the three pair of accessory masticatory organs) and whose pectoral portion also enters into the part usually called the cephalothorax†.

EXPLANATION OF PLATE VI.

Fig. I. *Locusta viridissima*, ♂, seen sideways.
Fig. II. The same, ♀; apex of abdomen.
Fig. III. A. *Pachytylus migratorius*, ♂, seen from beneath.
Fig. III. B. Terminal segments of the male of *Pachytylus migratorius*, seen sideways.
Fig. IV. A. *Pachytylus migratorius*, ♀; last abdominal segments, seen sideways.
Fig. IV. B. The same, seen from beneath.
Fig. V. *Forficula gigantea*, ♂; abdomen seen sideways.
Fig. VI. *Forficula gigantea*; metathorax (M) and first two abdominal segments.

XX.—*Note on the Colouring Matter of the Red Sea.*

By H. J. Carter, F.R.S. &c.

To those who have sought for all that has been published on the colouring matter of the Red Sea, it will be well known that the excellent memoirs on this subject by M. C. Montagne in 1844, and M. C. Dareste in 1855 (both in the 'Ann. des Sc. Nat.,' the former in sér. 3 (Bot.) t. ii. p. 331, and the latter in

* Erichson, Entomographien, pp. 14–16.
† Brandt, Medic. Zoolog. ii. p. 58; Erichson, *l. c.* p. 19.

sér. 4 (Zool.) t. iii. p. 179), are the most elaborate. But to Ehrenberg is due the merit of having first described (in 1826) the nature of the organism from which this colouring matter is derived. He found it in the Bay of Tor itself, pronounced it to be an Oscillatoria, and called it *Trichodesmium erythræum*, which Montagne has advisedly changed to *T. Ehrenbergii*.

No one who has read Montagne's memoir, and seen his illustration together with the organism itself, can doubt that the chief source of the red colour of the Red Sea is owing to the presence of this little Oscillatoria. Nor can any one doubt, who who has read M. Dareste's memoir, that this is not the only organism which colours the sea red in different parts of the world.

It was to confirm the observations of the latter, as well as to record the fact itself, that I wrote the paper in these 'Annals' for 1858 (vol. i. p. 258), entitled "On the Red Colouring Matter of the Sea on the Shores of the Island of Bombay," wherein it is shown that this colour depends on the presence of a *Peridinium* (*P. sanguineum*, Cart.) in innumerable quantities, in which the chlorophyll at first is green, then becomes yellow, and lastly red, when the latter, mixing with the oil-globules generated *pari passu* in the cell, gives rise together to greater opacity, and thus reflecting more strongly, makes the presence of the *Peridinia* more evident, and causes the sea in which they are contained rapidly and almost suddenly to become of a vermilion or minium-red colour; after which, the *Peridinium* falls to the bottom and thus disappears, as if this were the termination of a cycle in its existence.

It was not, however (although I had formerly spent many months on the coasts of Arabia), until returning to England in June 1862, on board the Peninsular and Oriental Company's steamer 'Malta,' that I had an opportunity of seeing the colour of the Red Sea which is produced by *Trichodesmium Ehrenbergii* —a circumstance to which I should not have alluded, had not Montagne appended to his memoir certain queries which, in part, I can answer, at the same time that, with much diffidence, I offer a few remarks on Montagne's generic characters of this organism, which are repeated by Kützing in his 'Species Algarum.'

Commencing, then, with a short account of my own experience of *Trichodesmium Ehrenbergii* in the Red Sea, I would observe that, on the 31st of May 1862, when approaching Aden, we passed through large areas of a yellowish-brown oily-looking scum on the surface of the sea, and that on the 2nd of June, when off the Arabian side of the first islands sighted in the lower part of the Red Sea after leaving Aden, it again appeared,

and we frequently passed through large areas of it, sometimes continuously for many miles, until we arrived off Jubal, or the last island in the upper part of the Red Sea, when, from a calm, we steamed into a strong northerly breeze accompanied by heavy sea, and saw no more of it. Once only I saw a portion of brilliant red and one of intense green together, in the midst of the yellow.

The odour which came from this scum was like that of putrid chlorophyll, well known to those who have had much to do with the filamentous Algæ, both marine and freshwater, but more familiarly, to those who have not had this experience, by that which comes from water in which green vegetables have been boiled,—and hence very disagreeable.

I drew up some of this scum in a bottle, and found it to be composed of little short-cut bundles of filaments like Oscillatoria; for I had only a Coddington lens with me for their observation; and on showing them to Mr. Latimer Clark, the well-known Superintendent for laying down the telegraph-cable through the Red Sea, &c., to Kurrachee, who was on board, Mr. Clark stated that he had observed the same phenomenon in the Sea of Oman, where he had examined the filaments of the little bundles with a microscope, and had found them to be "beaded," to use his expression, "with rounded extremities."

On arriving in England, I had no time for examining microscopically the specimens which I had obtained, and which had been preserved in an equal quantity of alcohol added to the sea-water in which they had been taken, till January (1863), when I found the little bundles, which were still just visible to the unassisted eye, and like so much fine "sawdust" (to which they have been aptly and commonly compared by previous observers who have seen them without knowing what they really were), varying in point of measurement, although, on the average, perhaps about $\frac{1}{30}$ inch long by $\frac{1}{100}$ broad, containing about twenty-five to sixty filaments, each of which is about $\frac{1}{30}$ inch long by $\frac{1}{2400}$ broad, their cells, which of course are so many disks, being sometimes thinner, sometimes thicker, than the breadth of the filament, with rounded cells terminately at the extremities where entire, but square when the latter have been broken off from the filament. The bundles bore no evidence of an investing sheath, but of the filaments being held together by mucus secreted from them generally.

Further into this description I need not enter, except to state that the cell was a true Oscillatorial one, charged with a few granules suspended in its protoplasm, and that I saw nothing like sporidification.

The colour of the bundles to the unassisted eye was still faint

yellowish; but the filaments, under the microscope, were faintly green.

Of the questions proposed by Montagne (*op. cit.* p. 355), the second calls for more information on the size of the bundles. This has been supplied above, so far as my observation extends.

The third question calls for information respecting the presence of *Trichodesmium* in the Sea of Oman, &c., as bearing upon the origin of the name "Erythræan Sea," applied by Herodotus to *all* the seas washing the shores of Arabia.

I have already stated that I saw the scum in the Gulf of Aden, also that Mr. Latimer Clark had seen it in the Sea of Oman; and the following extract from the late Dr. Buist's observations on the "Luminous and Coloured Appearances in the Sea" (Proceedings of the Bombay Geographical Society for 1855, p. 120) will show that it exists in the upper part of the Indian Ocean. The account from which this is taken was communicated to Dr. Buist by Dr. Haines, as witnessed on board the 'Maria Soames,' in lat. 21° N. and long. 42° E., and it stands thus:—

"In May 1840, when one-third across from Aden to Bombay, the aspect of the sea suddenly changed upon us, and at once seemed as if oil had been poured upon its surface. It was still as a mill-pond, and of a brownish, soapy hue. The water, on being examined, was full of little fibrils, like horsehair cut across, in lengths of the tenth of an inch or so. A wine-glass full of it contained hundreds of them.... We sailed through them for about five hours; so that they probably extended over a surface of 500 miles."

The occurrence, then, of *Trichodesmium Ehrenbergii* in the Red Sea, the Gulf of Aden, the Indian Ocean, and the Sea of Oman is so far substantiated; and as the yellow colour in all instances probably passes into red, we have apparently the explanation of the whole of these seas having been called by the Greeks "Erythræan." I have not, however, heard whether it has been seen in the Persian Gulf.

Further, we learn from M. Dareste's memoir (*op. cit.* p. 208) that João de Castro, in July 1841, when off Cape Fartak, which is about the middle of the south-east coast of Arabia, found the sea so red that it appeared as if it had been coloured with bullocks' blood.

In my own experience of the Sea of Oman and the whole shore-sea of the south-east coast of Arabia from Muscat to Aden, where, under its survey, I passed all the months of the years 1844–45 and of 1845–46, with the exception of those of the stormy monsoon, viz. June, July, August, and September, the presence of the scum above described never, to my knowledge,

was once observed. I am therefore inclined to infer that it is chiefly confined to the sea some distance off shore. Yet Ehrenberg, in 1823, saw the Bay of Tor covered with it, even up to the sands.

Lastly, I would advert, but, as before stated, with much diffidence, to that part of the generic characters of *Trichodesmium Ehrenbergii* in which we find the expression "*prime rubro-sanguineæ, tandem virides,*" first used by Montagne (*l. c.* p. 346), and then repeated by Kützing in his 'Species Algarum,' because the facts connected with the accounts given of those who have seen the scum formed by *Trichodesmium*, together with my own experience of Algæ generally, lead me to the opposite conclusion, viz. that *Trichodesmium* is at first green, and subsequently becomes red.

It is true that its chief colour in the Bay of Tor, when seen by Ehrenberg, was red; it was red, like "red sawdust," when seen by M. E. Dupont in the Red Sea (*ap.* Montagne, *l. c.*): but, on the other hand, what I saw in the Gulf of Aden and in the Red Sea, together with what Mr. Latimer Clark saw in the Sea of Oman, and Dr. Haines, as above stated, in the Indian Ocean, was nearly all of a yellow oily colour; and this is the appearance that I have heard generally assigned to it by those who have been in the habit of traversing the seas mentioned.

Next to the yellow colour, red is the most prevalent, and green least of all. Some of that seen by Ehrenberg was intensely green; this was the case also with the green portion that I saw with the red above noticed; while Ehrenberg saw other portions of a less green colour. So much for what has been stated respecting the colours under which *Trichodesmium* has appeared.

We come now to the usual course presented by other Algæ in arriving at a red colour. If we take the *Peridinium* which colours the sea red on the shores of the island of Bombay, we shall find, as above stated, that it is at first green, then yellowish, and lastly red. In the green stage, the contents of the cell are so thin and watery that they easily allow the light to traverse them, and thus the *Peridinium* passes unobserved; but as they become inspissated, oil-globules generated, and the chlorophyll changed first to yellow and lastly to red, these contents become more opake; and thus the *Peridinium*, by reflecting much more light than it did at first, comes rapidly into notice, and by its numbers gives a general red colour to that part of the sea in which it may be present. The same is frequently, indeed commonly, the course with *Euglena* in freshwater ponds. The little *Protococcus* which colours the salt red in the salt-pans of the Island of Bombay, is green in the active period of its existence,

but becomes red, and settles down into the "still form" of the same colour; while the common green *Protococcus* of the fresh-water tanks loses its red spot in the still form, and gains it again in the active or reproducing period of its existence. So red *Euglenæ* often become green; but the usual course appears to be for the green to appear first.

The red colour also appears to herald the termination of some period in the existence of the species. Thus the *Peridinium* above mentioned, after becoming red, loses its cilia, assumes the still form, and sinks to the bottom. The same is the case with the *Protococcus* of the salt-pans of Bombay; but instead of adhering to the salt, it seeks out and settles upon the crystals of carbonate of lime that are among those of the salt. The chlorophyll changes from green to red also in some of the resting spores of the confervoid Algæ, as in *Sphæroplea** and in *Protococcus pluvialis*, where also in both it becomes green again on germination, which led Cohn to state that the green colour is connected with "vegetation" or the early part of the existence of the individual, and the red with "fructification" or the termination†. So that, altogether, the passage of the colour from green to red in the filament seems to be more likely than the opposite.

Thus, as the evidence regarding *Trichodesmium* in the seas above mentioned is more, if anything, in favour of its yellow than its red colour, and that it is also sometimes green, while, in the common course, where Algæ present red and green colours in their respective cycles of existence the latter appears first, and the *Peridinium* above mentioned passes from green to yellow and then to red, &c., it seems not unreasonable to infer that *Trichodesmium Ehrenbergii* does the same, and that, therefore, so much of Montagne's generic characters of *Trichodesmium Ehrenbergii* as relate to its colour (viz. that it is "at first red and at length green") should be reversed.

If it were desirable to adduce evidence of the faint green colour which *Trichodesmium* probably presents in the first stage of its existence, from the observation, too, of probably the same organism in other parts of the world, one might cite those of Péron, who likens it to "poussière grisâtre," and of Darwin, who compares it to "cut hay," &c. (*op. cit.*); but it seems better for this argument not to go beyond the seas washing the shores of Arabia.

To what the "intense green," under which this organism sometimes presents itself in the Red Sea, owes its production I am ignorant, unless it be indicative of sporidification, which,

* Cohn, Ann. des Sc. Nat. 4e sér. t. v. p. 187.
† Ray Soc. Vol. for 1853, p. 519.

from what I think that I have seen in *Oscillatoria princeps*, seems to take place in this family, not from the conjugation of its cells, but from the division of their contents into zoospores. Much therefore remains to complete the history of this little plant; and this, unfortunately, can only be obtained by watching it long and narrowly in its proper habitat.

XXI.—*On the Contractile Tissue of Plants.*

By Prof. Ferdinand Cohn*.

Prof. Cohn commences his interesting essay by remarking that, though modern discovery has rendered the boundary-line obscure between the animal and the vegetable kingdoms, with respect to the lowest organisms in each, yet the differential characters between the higher forms of each subkingdom remain sufficiently well marked. Nevertheless the phenomena of irritability and of movement in parts of many higher plants bear a general resemblance to those presented by the tissues of the higher classes of animals, though their active cause has been attributed to mechanical forces in connexion with structural peculiarities. Cohn addresses himself to the question whether these mechanical hypotheses are sufficient and satisfactory, or whether the movements and irritability of plants are not referable to structures homologous with those concerned in their production and manifestation in animals.

To solve this interesting question, Cohn appeals to observations made by himself and by a talented pupil, M. Krabsch, who was induced by the Professor to repeat, in the first instance, the old experiments of Treviranus and Morren on the irritability of the filaments of *Centaurea*, as a prelude to new researches. Köhlreuter established the fact of the irritability of the stamens of *Scolymus hispanicus*, *Serratula arvensis*, *Cynara scolymus*, and *C. cardunculus*, *Onopordum arabicum*, *Centaurea moschata*, *C. nigra*, *C. spinosa*, and *C. ragusina*, *Cineraria*, *Scabiosa glastifolia*, *S. benedicta*, *S. eriophora*, and *S. salmantica*, *Buphthalmium maritimum*, *Cichorium intybus*, and *C. endivia*, and *Hieracium sabaudum*. Sowerby noticed the contractility of the anthers in *Centaurea Isnardi*, and L. C. Treviranus made a particular study of the movements of the filaments of *Centaurea pulchella*, whilst Morren did the same for those of the *Centaurea ruthenica*. Krabsch especially studied the movements of the anthers of *Centaurea macrocephala*.

* Translated, in abstract, from the 'Abhandlungen der Schlesischen Gesellschaft für vaterländische Cultur,' Heft i. 1861, by J. T. Arlidge, M.B. & A.B. (Lond.).